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THE SPIRIT AND SERVICE OF SCIENCE[1]

By Professor DAYTON C. MILLER

THE CASE SCHOOL OF APPLIED SCIENCE

The occasion of this convocation is the fifty-second commencement of the Case School of Applied Science, bringing to a close the fifty-fifth year of the activities of the school. Since my early school days I have been absorbed in the study of the philosophy of science; for forty-six years I have been a member of the faculty of Case School of Applied Science and have endeavored to promote the usefulness of science, with ever-increasing enthusiasm. I am convinced that science, in the broad sense, has arrived at the beginning of a new era in its history; this is "Commencement Time" for science, when it must assume new duties and obligations. My friend, Sir Richard Gregory, editor of the English scientific journal, *Nature,* has used a phrase so concise and explicit that I wish to adopt it as the title of this address, "The Spirit and Service of Science."

[1] The commencement address, June 1, 1936.

The Spirit of Science

The greatest effort of thinking man, since the beginning of civilization, has been to find a reasonable set of answers to his own questions concerning reality, origin, destiny, duty and hope. This organized body of highest truth constitutes philosophy; it is an inquiry into the first principles of things, as distinguished from science, which generalizes the scattered operations of nature into laws. The Greeks laid the foundation for our system of philosophy. The Eleatics before Socrates anticipated many modern theories, but rather by guessing than by research; a mythological explanation was assigned to a phenomenon of nature. Socrates was the first real philosopher; he introduced the method of hypothesis. Plato, the disciple of Socrates, concluded that the objects of real knowledge are not the ever-changing things of the sensible world, but are immutable, eternal objects which he called

"Ideas." Then Aristotle, the great architect of the whole structure of philosophy, constructed his logical system of truth, based upon "form" and "method," and made it the greatest contribution of the Greek mind to the progress of civilization.

The early philosopher had knowledge of only a very limited number of phenomena. As knowledge increased, the wise men began to "speculate" as to the causes of things; because there were not other known phenomena sufficient to test a theory, no general consensus of opinion was reached, and each philosopher had a system of knowledge of his own. After this came the ages of skepticism, gnosticism and scholasticism, "cloud-built, and mostly empty," until Francis Bacon arose in the sixteenth century and proposed a new method, based upon experimental research. He was the first to consider the philosophy of inductive science, and he wrote elaborate treatises on the theory of the new method of experimentation, though he himself made no striking or successful experimental contribution to the knowledge of nature.

Galileo, born in 1564, three years later than Bacon, is the real founder of the modern scientific method. This consists in making certain experiments and observations, and then by the use of the scientific imagination, induction, a hypothesis is formulated by means of which future particular facts can be predicted. Further facts are collected to prove or disprove the consequences deduced from the hypothesis; thus the number of facts to be examined becomes manageable, and we acquire rapidly a knowledge of the truth and ultimately are able to establish a general law of nature.

What is the real "Spirit of Science"?

Saint Paul says: "Prove all things; hold fast that which is good"; and Saint Matthew adds: "By their fruits ye shall know them." Taken together, these simple philosophical quotations give an almost perfect description of the scientific method.

Michael Faraday gave the following description of the correct attitude of a research worker:

> The scientist should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; should have no favorite hypothesis; be of no school, and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the temple of nature.

The late Arthur Gordon Webster, American physicist, formulated the scientific method in these terse words: "Think, calculate, plan, experiment, think,—first, last, and all the time, *think.*" He contrasts this with the method commonly pursued: "Wonder, guess, putter, guess again, theorize."

In the scientific method, experiment is the source of truth, and it alone can give us certainty. The method requires a consideration of all the facts in the case, and the formulation of conclusions in accordance with the facts; if any part of the conclusion is uncertain or unjust, then researches must be undertaken to determine new facts by observation and experiment; this process must be continued and repeated, no matter how laborious, until the truth appears.

Experimentation proceeds largely upon the principle of cause and effect; it requires the control and quantitative evaluation of the factors involved, in order that definite relations may be established as laws of nature. Modern technique has made possible great precision and certainty. The sciences involving accurate measurements are designated exact sciences in distinction from sciences which depend upon the description and classification of phenomena. From the quantitative relations, the scientist may predict a future event, or the engineer may design a structure adapted to a specified use.

A truth once discovered always remains a truth; new truths are added and knowledge grows, evolution, not revolution, being the method. The great object of human endeavor, beyond mere animal existence, is the attainment of knowledge; this, together with the altruistic purpose of preserving and transmitting knowledge for the enrichment of the lives of future generations, are the motives which have created our great universities, libraries and museums.

The gospel of science is the gospel of work. By nothing but patient toil and the quiet thought which it brings, can a scientific habit of mind be acquired. Scientific investigation is not often undertaken with personal profit in view, and frequently the researcher is denied not only the luxuries of life but even what other successful men regard as the necessities. The discoveries of the scientist are not jealously kept within the precincts of the laboratory, but are offered freely to the world.

Happily, at times, research becomes of absorbing interest and gives pleasure and satisfaction beyond that of most other occupations. The worker in science must count this as his compensation instead of the monetary rewards which the man of affairs confidently expects.

Paradoxical as it may seem, all exact science is dominated by the idea of approximation, that is, completeness and perfection are never attained. An experimental result is always given with a statement of its "probable error," indicating its relative precision and certainty. Who ever heard of a politician concluding his speeches or of a theologian prefacing his creed with a statement as to the probable error of his opinions? It is an odd fact that subjective certainty is inversely proportional to objective certainty;

this contrast is illustrated by the dogmas of art and of science.

It is evident to a sympathetic observer that the relations between men of science and the general public are not always such as to secure the best interests of both. There is a wide-spread opinion that a scientist is a sort of recluse, a book-worm, a high-brow, who has cut himself off from communion with his fellows, and especially from what the business man calls practical affairs, and that he has become an impractical, visionary "theorist" who is almost to be pitied; that he is a scientist merely because he is a fool who does not know enough to make money. To the credit of the scientist, it may be said that he is usually regarded as a harmless creature and that to render him encouragement and assistance is often regarded as a virtue.

It frequently happens that when new ideas are brought forth, evil-minded persons take advantage of them for selfish purposes; in this manner the contributions of science have been perverted to base ends, subjecting science itself to unjust criticism. Much of the criticism is caused by the fact that the scientific method is, in general, evolutionary, that is, it tends to produce changes in accordance with increased knowledge and improved conditions. The politician violently opposes the application of methods involving the open presentation of a situation, and the drawing of conclusions based upon a complete study of all the facts. Many ecclesiastical bodies obstinately resist changes of doctrine or procedure and refuse even to consider newly discovered facts which bear upon their affairs. The ignorant and uninformed in general manifest an astounding intellectual inertia and refuse to modify their superstitions.

The scientific dilettante, or worse, the charlatan, is often much nearer to the public than the honest man of science, and the inability to discriminate results in disaster to both the scientist and the public. The astounding prevalence, in this enlightened day, of the horoscope, the astrologer and the soothsayer is a disheartening illustration of this fact.

In our universities even, often there is a lack of adequate appreciation of the scientific method. Scientific and humanistic studies are presumed to be antipathetic and to represent opposing qualities; science being associated with that which is cold and mechanistic in our being, while the development of the more spiritual parts of man's nature is attributed to other departments of intellectual activity. However, in truth, direct contact with nature and inquiry into her laws produce a habit of mind which can not be acquired in literary fields and which is associated with a wide outlook on life more often than is commonly supposed.

In quite modern times the professors of scientific, and of unscientific, subjects have been denominated "brain-trusters," sometimes in contempt or ridicule, but, I hope, sometimes with respect. If the brain-truster is worthy of his classification, he will adhere to the specifications of a true scientific researcher, and he will find justification.

When attending the meeting of the British Association for the Advancement of Science, three years ago at Leicester, during a procession of the members I stood on the curb to obtain photographs of Sir Oliver Lodge and some of the other notables. Beside me stood two of the citizens of Leicester, evidently of the common people. As the scientists were passing, one of the citizens said: "Ah, them has brains!"; and his companion replied: "Aye, I wish I had some too," expressing the noble virtues of humility and respect for his superiors.

Science and Philosophy

Some have doubted that the modern scientist possesses the idealism and faith necessary to the true philosophy. The scientist has been accused not only of not having any ideals of his own, but of being bent upon destroying the ideals of others. It may be incumbent upon the man of science to proclaim his philosophic conclusions as well as to announce the spectacular conquests of nature.

Existence is a struggle, and we are urged on by a hope of comfort and gratification and of a life of happiness. Every contemplative person, in the beginning, expects to formulate a philosophy of life which will indicate the ends to be striven for, and such that it will stimulate the motives of action and lead to the satisfaction of attainment. The term of existence is so short and incomplete that in this struggle the happiness acquired by an individual varies greatly and in a manner that often seems unjust. In order that life may be worth living for an intelligently thoughtful being, there must be something more than the momentary results of action, whether these be rewards or punishments; there must be a goal towards which integrated human accomplishment advances. In mathematical language, existence is an infinite series of individual lives, some positive, some negative, some of the first power and some of higher powers, but the sum of the series must approach a limit which is an ultimate good far transcending in importance any single term of the series, and the nature of which may be quite independent of that of any single term. This final sum of the series may be called an "ideal" which extends beyond the experiences of this life, which becomes an eternal verity, and constitutes reality, and our philosophy wishes to describe and even to explain it.

At Princeton University, forty-nine years ago, being determined to find a metaphysical basis for experimental science, I joined a group of perhaps ten seri-

ously minded students who went once a week to the library of President James McCosh. We literally sat at the feet of this great Scotch-American philosopher while he expounded a philosophy of realism, opposed to idealism on the one hand and to agnosticism and materialism on the other. Those of my teachers who have impressed me above all other men are Dr. McCosh, Charles A. Young, the Princeton astronomer, and Cleveland's own Edward W. Morley, a triumvirate of profound and scientific philosophers.

Realism holds that there are real things and real "values." We can not by pure reasoning prove the existence of either mind or matter. If we are ever to get hold of reality, we must seize it at once, and having whole-heartedly accepted it, we are to proceed to develop a system of philosophy which will be fundamentally scientific. I am prepared to adopt as the realities which constitute the universe three manifestations of absolute value: things which are eternally true—*science;* things which are intrinsically good—*ethics*—and things which are inherently beautiful—*esthetics.* There are not three different worlds of values; there is one universe of reality, a unity of the good, the true and the beautiful. And more, we must believe in the inherent and everlasting ability of mankind to progress towards an ultimate ideal or destiny, which requires that one's life be so ordered as to be in harmony with these eternal virtues. Such a life brings the greatest happiness and satisfaction.

It is not our observation or induction of these things that makes them realities; rather, we are sure we know them, we seek them, we cling to them, we are not satisfied with anything less nor indeed with anything else. This realistic philosophy is accepted in accordance with what the scientific man calls a "postulate"; others may well say it is accepted as a matter of "faith." Such a system of philosophy is not new, in fact, it is one of the oldest systems.

The aim of life should be to secure the greatest development and manifestation of these qualities, and a life based upon such an ideal should bring the greatest happiness and satisfaction. Mere physical pleasure is a part of the reality of nature, and its pursuit is not only allowable but is laudable. However, the foolish man often overlooks the fact that nature is scientific and ethical in its very essence, as well as esthetic and epicurean, and that sooner or later he must submit to the inevitable consequences of his actions; the wise man knows that the most exquisite and satisfying pleasure comes to him who practices his enjoyments with regard to the unity and solidarity of nature. The universe does not keep its ethics in one compartment and its beauty in another, to be sampled as one selects; it is true throughout, it is beautiful throughout, and it is ethical throughout.

There is no conflict between science and real religion. It is not within the province of religion to circumscribe science nor to limit beauty. It is no part of the work of science to prove or to define religion. Ethics is just as real and just as fundamental as science, but not more so. The study of science should and usually does increase one's appreciation of the principles of ethics. The study of the laws of physics gives one an enhanced appreciation of the beauties of music, the subtlest of all the arts. The contemplation of any part of the universe of reality enlarges one's understanding of the whole.

I would quote from the writings of several physicists, with each of whom it has been my great privilege to be personally acquainted.

Henry A. Rowland, the first professor of physics of Johns Hopkins University, became the leading physicist of America. His love of truth held him in supreme control. He describes a scientific observer in the following words:

> I value in a scientific mind, most of all, that love of truth, that care in its pursuit, and that humility of mind which makes the possibility of error always present more than any other quality.

Lord Kelvin, England's greatest physicist, said:

> I believe that the more thoroughly science is studied the further does it take us from anything comparable to atheism.

The late Lord Rayleigh has said:

> It is a strange world, and perhaps the strangest thing of all is that we are here to discuss it. I may say that in my opinion true science and true religion neither are nor could be opposed.

The late Michael Pupin, of Columbia University, upheld upon every occasion the high ideals of science, and said:

> The worship of eternal truth and the burning desire to seek an ever-broadening revelation of it constitute the mental attitude which I call "idealism in science."

The late Dr. John A. Brashear, of Pittsburgh, with whom I became acquainted in my college days, has always been a source of inspiration. In the making of astronomical instruments of precision he was the peer of any man of his time. Much as he loved and revered the science of astronomy—and surely no man ever loved it more—he said:

> The science most worth while in this world is that of extracting sunlight from behind the clouds and scattering it over the shadowed pathways of our fellow travelers.

His ashes, together with those of his life-long helpmate in good deeds, lie in the crypt under the great

telescope of his own construction in Pittsburgh. The marble plate bears the inscription:

We have loved the stars too fondly
To be fearful of the night.

CONTRIBUTIONS OF SCIENCE

That science develops a broad and inspiring view of the universe is evident; the spirit of science is surely noble, but what of the fruits of science, what does it signify in relation to our practical everyday life? What "service" can science render? The results of scientific investigations have contributed beyond measure to the alleviation of human suffering, have become of very great value in many industrial operations, have added incalculably to the entertainment and pleasure of human beings, and have attracted the widest possible attention; it would require a long series of lectures to give even the briefest outline of these contributions of science.

A few conspicuous scientific achievements of recent years are the telegraph, cable and telephone; the phonograph; wireless telegraphy and radio-telephony; electric generator, motor and electric light; photography and motion pictures; x-rays and radium; and aviation. Each of these advances came from simple research in pure science, carried on laboriously and patiently by a sincere scientist, who worked in his laboratory, his one purpose being to discover the secrets of nature, to find the essential truth; and without expectation of mercenary reward. Every one of these scientific discoveries has become the basis of an enormous industrial enterprise.

It can easily be shown that the triumphs of industry, which have so enriched many practical men, would never have existed if only these practical men had lived, and if they had not been preceded by disinterested scientific men, who died, poor, who never thought of utility. Mach, the Austrian philosopher, has said: "What these 'fools' did was to save their successors the trouble of thinking." Since it seems to be necessary to think for those who do not like thinking, and as they are many, each one of our thoughts should be useful in as many circumstances as possible! For this reason, the more general a law is, the greater is its value.

Not only has a scientific research started profitable industries, but many times a further research of a purely scientific character has been necessary for the continued success of the enterprise.

The first Atlantic cable was laid in 1858, according to specifications of the practical engineer; it was operated with difficulty for two months, when it failed completely because of faulty design and improper operation. William Thomson, afterwards Lord Kelvin, then a young professor of physics in the University of Glasgow, carried on extensive theoretical and experimental investigations which solved the difficulties; a second cable, laid in 1866, operated successfully.

After the telephone had been in practical operation for twenty-five years, it was still impossible to communicate over wires more than a few miles in length. It was the theoretical and experimental researches of Heaviside in England and of Pupin in this country, made in accordance with the principles of pure science, which rendered long distance telephony possible.

In many cases where the application of scientific principles is not so evident, yet the debt to science may be even greater. It has recently been stated that the steel industry at the present time is making use of at least five fundamental scientific discoveries which originally were worked out in college laboratories by private investigators, the loss of any one of which would make the steel industry impossible.

Lord Kelvin made many scientific discoveries and inventions which are useful in navigation; it has been estimated that no less than two hundred of these are involved in the operation of a modern ship.

It is often supposed that the marvelous development of aviation within recent years owes nothing to pure science. It was not a practical engineer who made the first flying machine; it was Samuel P. Langley, secretary of the Smithsonian Institution, of Washington; he made experiments in a physical laboratory, according to scientific methods, which led to the discovery of the theory of true flight. After flight was possible, it required many other scientific discoveries to make it practicable. When Charles Lindbergh made his "lone eagle" flight to Paris, he declared that the marvelous achievement was due in large measure to the induction compass with which his plane was equipped. This is an instrument based upon scientific principles which were developed in the physical laboratory.

Dr. Irving Langmuir has stated that the recently introduced gas-filled incandescent lamp saves $2,000,000,000 per year, or more than $5,000,000 per night, in the cost of electric illumination.

The illustrations given have all been taken from the science of physics. Other examples could be chosen from such sciences as medicine, chemistry, mineralogy, biology and others, which might be even of greater importance in their commercial aspects or in their relations to human welfare.

A most important semi-public scientific institution, devoted to pure science and equally to the uses of science, came into existence because of conditions created by the Civil War. Upon the recommendation of President Lincoln, the National Academy of Sciences was chartered by Congress in 1863. The

charter provides that "the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be paid from appropriations which may be made for the purpose, but the Academy shall receive no compensation whatever for any services to the Government of the United States."

The National Academy in this country corresponds in general to the Royal Society of London, and to the Academy of Sciences in France. The Academy membership, limited to three hundred persons, consists of groups representing all the natural sciences. Election to the Academy is based only on distinguished services to science, and is the greatest scientific honor that one may receive.

The National Research Council of the National Academy of Sciences was organized in 1916, in accordance with an executive order signed by President Wilson, as a measure of national preparedness. The Council was perpetuated, at the further request of the President, on a peacetime basis; for the purpose of "stimulating research in mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare."

The Science Advisory Board was created by President Roosevelt in July, 1933, "with authority, acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific problems in various departments of the Government."

The headquarters of the National Academy of Sciences is in Washington, where it has its own building on Constitution Avenue facing the Lincoln Memorial; the building is of great architectural beauty and is a worthy Temple of Science.

Science and Public Service

After having called attention to the beauties of the scientific method, and having mentioned some of its wonderful achievements, a very practical question which may be raised by those of the audience, and especially by the members of the graduating class, is: "Just what are we individually expected to do about it?"

Obviously, it could not have been according to a specified purpose that Madame Curie discovered radium, that Galileo invented the telescope, that Faraday discovered the laws of electromagnetic induction, or that Newton discovered universal gravitation. Even though you can not make discoveries at will, you can nevertheless deliberately make use of the scientific method to solve known problems, with the expectation of obtaining better results than by the use of any other method. Probably not many of you will adopt pure science as a profession, and it is to those who do not do so that my message is especially directed.

The primitive motives of selfishness and greed are at this moment rampant the world over, and, feeding upon democracy, are threatening the overthrow of law and order and the destruction of the cherished institutions of our higher civilization. The scientist has given man control over immeasurable forces of nature, but has not yet taught him to apply scientific methods to the control of his emotions.

Professor R. A. Millikan says:

> The future progress of the world depends upon whether man uses the old jungle method of thinking or whether he will make his thinking scientific.

Sir Richard Gregory, of London, the editor of *Nature,* says:

> Whether anything worth preserving can long remain in our civilization under present conditions and leadership may well be open to doubt. If freedom and democracy are to endure, this constrains the man of science to hold a watching brief, lest the name of science be taken in vain and the power of the franchise be abused by an uninstructed electorate.

Lest there be misunderstanding, I may state emphatically that I am not making a plea nor even suggesting that the affairs of state and society be turned over to the professional scientist. But I am proposing, indeed am demanding, that the man of public affairs shall adopt the philosophy and methods of procedure which have been developed in the world of science.

Sir Frederick Gowland Hopkins, in his recent presidential address before the Royal Society of London, said:

> What seems to be really desirable is some method of closing the gap between the mind and outlook of the publicist and those of the trained scientist. It is time, perhaps, that the building of a bridge should begin on the scientific side of the gap.

A scientific theory, as already mentioned, is not a vagary of a dreaming mind; it is a statement of a fundamental truth, an explanation of real things based upon practical experience, and it is acceptable only in so far as it conforms to reality. What can be more real and practical than the theory of gravitation or of the sustaining power of the air upon an airplane, though both are invisible! The scientist is not a mere theorist, but, far more than the man of business, he comes into direct contact with practical realities; it is

the scientist who meets real difficulties and knows how, or learns how, to overcome them. To make a shrewd guess as to future values or to drive a sharp bargain is not the way to become acquainted with the real, practical things of this world.

How unscientific are the methods of expediency, common in commercial activity and embodied in such processes as "promotion," "publicity" and "high-powered salesmanship"! In "selling the public" some facts are usually set forth, but rarely are all the facts employed. Certainly a promoter may be honest, and still not set forth all the facts, and the buyer may receive full justice, if both have the scientific state of mind; but when the scientific attitude is not present, what calamitous opportunity for fraud and injustice lies in the current methods!

The scientific method is greatly needed in the solution of social and moral problems. It is strictly in accord with the scientific view that a successful form of government requires of every citizen, individually, a strict obedience to law and order. "Personal liberty" is not based upon a consideration of all the facts, it is usually only personal license and selfishness, and when one claims this as his right in justice, he denies equal justice to others.

A few days ago I stood in front of the impressive building of the United States Supreme Court in Washington; the well-known legend on the frieze caught my attention and I pondered its significance. It did *not* read: "Complete justice for each individual"; instead it proclaims: "Equal justice under law"—a scientific rather than an emotional "motto"!

Referring to the dictionary, "politics" is there defined as "the art or vocation of guiding or influencing the policy of government through the organization of a party among the citizens, including, therefore, not only the ethics of government, but more especially, and often to the exclusion of ethical principles, the art of influencing public opinion, of attracting and marshalling voters, and of obtaining and distributing public patronage." "Diplomacy" is defined as "dexterity and skill in managing negotiations of any kind, with the view of securing advantages." Surely here are needed methods involving the highest ideals and the truest philosophy.

The scientific method is needed in municipal and state affairs. The "business manager" plan of conducting public business is scientific in its original intent, and it should be sustained to the utmost. Every citizen of the state of Ohio should apply the scientific method to the study of the principles of taxation, and our law-makers should use the method in devising and passing adequate and just tax laws.

In national and international affairs the just settlement of several important questions demands the application of the strict scientific method. Among such questions are the coordination of the various departments and bureaus of the government and the budget system of making appropriations; the tariff on imports; the settlement of foreign war debts; and even the question of war itself. The League of Nations is, when honestly considered, the most impressive application of the scientific method which the world has known, and perhaps, ever can know. How unscientific it is to consider it in a partisan spirit!

The late Professor T. C. Mendenhall, one time director of the United States Coast and Geodetic Survey, fifty-six years ago gave an address as president of the American Association for the Advancement of Science, in which he said:

> The computation of the trajectory of a planet may be an easier task than forecasting the true policy of a great republic, but those qualities of the human intellect which have made the first possible should not be allowed to remain idle. The presence of one or two men of science in each branch of the Congress would be of decided advantage to the whole country.

We do not recall that the voting public has ever sent a senator or representative to Congress primarily because he was a profound scientist. In contrast, it long has been and is now the custom of the electorate of Great Britain to send representatives to the British Parliament solely because they are eminent men of science. May we dare to hope that some of the graduates of Case School of Applied Science may be sent to the legislative branch of the government?

Not only should the judgment and taste of the general public be cultivated to secure a greater reliance upon the scientific method, but since men of science have exhibited an inexcusable apathy towards matters of public service, it is necessary to exhort them to consecrate their abilities and knowledge to the betterment of life in general and to assume the responsibility not only for making new discoveries but also for the beneficent use of these new powers, lest they be applied destructively. The public may justly demand that the active interest of the man of science in public affairs shall not be less than that of other men.

To the Graduating Class

In addressing you, the members of the graduating class of Case School of Applied Science, I do not plead for the study of specific sciences, such as astronomy, geology, physics and chemistry; you are already well versed in these subjects, and I hope you will never cease to enjoy their continued advancement. While these sciences have been developing, the broad "spirit of science" has grown into our intellectual processes and there has been evolved the perfected method of philosophy.

You, young men, have for four years had the advantages of the best training for life's duties that the universities know how to give. It is expected that you will be honest and successful private citizens; and of greater moment, your home city, your state, your nation and your Alma Mater, have the right to expect of you the highest type of leadership and the manifestation of the highest ideals in public affairs, for the benefit of all.

Plato said: "Might is right"; two thousand years later Milton said: "What is strength without a double share of wisdom?" and Browning adds: "The great mind knows the power of gentleness, only tries force because persuasion fails." Finally, Lincoln said: "Let us have faith that *right* makes might; and in that faith let us dare to do our duty as we understand it."

If the ideal of democracy is to be attained, I believe that the application of the true scientific spirit to the affairs of state will assist more than anything else at the present time. You are certainly of the chosen people, and I beseech you to accept the responsibility in all seriousness.

Probably, every graduating class that ever passed from college halls has been told that upon its shoulders rest the burdens of the world. It is a statement which, however trite, is, nevertheless, true. I have spent a lifetime teaching college students, and I know that each year the lessons must contain the same fundamental principles as were taught a year ago, ten years ago and even hundreds and thousands of years ago; but the lessons should be given with ever-increasing effectiveness as the world's experience and knowledge increase. I have the privilege of giving you the last lesson of your college course, for within the half-hour you will have graduated; in concluding this lesson on the old subject of the opportunities and responsibilities of youth, I am counseling you to make the fullest possible use of the spirit and service of science.

SCIENTIFIC EVENTS

THE EDWARD GREY INSTITUTE OF BIRD STUDIES

In the issue of SCIENCE for September 18 there was printed an appeal for subscriptions for the three-fold memorial which it is proposed to establish in England to commemorate the late Viscount Grey of Fallodon. The third object of the memorial is to develop the existing scheme of research maintained by the British Trust for Ornithology at Oxford, of which university he was an undergraduate and in later years the chancellor, to form a permanent Institute of Bird Studies, to which his name would be attached.

In pursuance of this object it is proposed to establish the Edward Grey Institute of Bird Studies, which is described as follows:

Lord Grey's love of wild birds, and his genius for expressing the widely shared delight in watching them, won him the affection of thousands of people in England and oversea. As chancellor of Oxford University he warmly supported the attempts then being made to create a team of field observers centered on the university.

It is therefore fitting that his memorial, after provision of the statue or bust, and acquisition of Ross Castle, should be a permanent endowment of bird-watching in the British Isles, under university direction, and styled the Edward Grey Institute of Bird Studies. This would provide a small but suitably staffed institute situated at Oxford, to furnish help and advice to every one needing them on matters relating to wild birds and their habits. It will house the only library in the British Empire devoted to books, MSS., photographs and films about living wild birds and will initiate cooperative inquiries. It will not duplicate the work of any existing body, but will fill a conspicuous gap.

The British Trust for Ornithology, in collaboration with the university, has already made a good start in this direction. Teams of observers are successfully at work on experimental investigations, and a valuable library has been presented by a number of ornithologists. A generous response to the Viscount Grey Memorial Appeal will endow Great Britain with a model institute which will have no match in the world as a center for helping voluntary effort in the study of wild birds. Such a center will keep alive the memory of Lord Grey by continuing his work of finding out how birds live and of stimulating more understanding of the pleasures and rewards of bird-watching.

THE MEDICAL CENTER IN JERSEY CITY

THE laying of the cornerstone of the Medical Building of the Medical Center of Jersey City by President Roosevelt was planned for the morning of October 2. He is to be welcomed by Mayor Hague and introduced by Senator A. Harry Moore.

The Medical Center is being financed by Jersey City, Hudson County, New Jersey, and the Public Works Administration. The Medical Building will be one of seven large structures of the skyscraper type and several smaller buildings, some of which are ready and others near completion. The center will provide ninety-nine floors for hospitalization, with beds for the accommodation of 2,000 patients.

The Surgical Building, the Staff House and the Nurses Building are completed. The Medical Building is under construction on the site of the old Jersey City Hospital. This building will cost $4,545,000 and is financed by Jersey City and the Public Works Administration.

The Hudson County Tuberculosis Hospital, which is complete except for furnishings and equipment, has been built at a cost of $3,960,000, financed by Hudson County and PWA. The sixth main building is the Margaret Hague Maternity Hospital, which is built, and the seventh is the Out-Patient and Psychiatric Hospital, financed by Jersey City and PWA at a cost of $2,500,000. The latter building, not yet under construction, is to be a ten-story structure.

Ground has been broken for a new eighteen-story building which will include the present six-story medical unit and the twenty-three-story surgical unit connecting wing.

The buildings are of steel skeleton construction, fireproof and of buff-colored brick. The exterior trim is granite and terra cotta. The floors are of terrazzo, with marble wainscoting in all corridors. Utility rooms, serving kitchens, general service rooms and operating and sterilizing rooms are completely tiled. The doors are of hollow metal with rolled steel bucks.

The approximate capacities of the various units will be as follows: Staff house, 150 doctors; surgical unit, 150 beds; medical unit, 650 beds; nurses' home, 500 nurses; tuberculosis hospitals, 500 patients, 100 nurses, 30 doctors; Margaret Hague Maternity Hospital, 300 adults and 300 babies; Out-Patient and Psychiatric Hospital, 300 beds; isolation unit, 30 beds.

THE NEW ORLEANS MEETING OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

The American Public Health Association will hold its sixty-fifth annual meeting in New Orleans from October 20 to 23. More than 2,000 public health workers are expected to attend from every state in the Union and from Canada, Cuba and Mexico.

Scientific sessions have been arranged dealing with current problems in the administration of nursing, school health work, health education, sanitary engineering, vital statistics, laboratory practice, child hygiene, industrial hygiene, epidemiology. There are programs covering overlapping interests which involve several groups of specialists who will come together in joint meetings for common discussion.

At the general sessions the following subjects will be considered: Advances in public health, in administrative technic, in the control of pneumonia, in engineering practice, in health education methods, in laboratory methods, in housing as a public health problem and in diphtheria immunization, mental hygiene, mosquito-borne diseases and professional education.

In a symposium on syphilis, administrative, epidemiological and laboratory aspects will be presented, respectively, by Dr. J. N. Baker, state health commissioner of Alabama; Dr. George H. Ramsey, director of the division of communicable diseases, New York State Department of Health, and Dr. A. H. Sanford, of the Mayo Clinic, at Rochester, Minn. The discussion will be opened by Dr. Thomas Parran, Surgeon-General of the United States Public Health Service.

The subjects of other symposia include industrial sanitation, dairy products, infant and maternal mortality, enteric fevers, nutritional problems, registration of births and deaths, care of communicable diseases in the home, food poisoning, sanitation of eating utensils, intestinal parasites, school-health education, school nursing, business aspects of the health department and publicity.

The American Association of School Physicians, the Conference of State Laboratory Directors, the Conference of State Sanitary Engineers, the Association of Women in Public Health, Delta Omega, the National Committee of Health Council Executives, the State Registration Executives and the International Society of Medical Health Officers will meet at the same time as the association.

On the invitation of the Cuban Government and health authorities of Florida the association will sponsor a post-convention tour to Havana via Florida by train, motor and steamer. Delegates are invited to join the tour.

The program can be obtained from the office of the association at 50 West 50th Street, New York City.

THE JOSIAH WILLARD GIBBS LECTURESHIP

The thirteenth incumbent of the Josiah Willard Gibbs Lectureship of the American Mathematical Society is Professor Henry Norris Russell, of Princeton University. The Institute of Physics has been invited to join with the society in sponsoring this lecture in New York City on October 31.

In 1923 the American Mathematical Society established an honorary lectureship to be known as the Josiah Willard Gibbs Lectureship, the lectures to be of a popular nature on topics in mathematics or its applications and to be given by invitation under the auspices of the society. This lecture is in honor of Gibbs, who ranks among the very first of the scientific men that America has produced. It is hoped that these lectures will contribute to the understanding on the part of the educated public of the service that mathematics is rendering to modern thinking and to modern civilization.

The first lecture was given in New York City by M. I. Pupin on "Coordination," under the joint auspices of the society and the American Association for the Advancement of Science. The second was given in Washington by Robert Henderson on the subject, "Life

Insurance as a Social Science and as a Mathematical Problem"; the third in Kansas City by James Pierpont on the topic, "Some Modern Views of Space"; the fourth in Philadelphia by H. B. Williams on "Mathematics and the Biological Sciences"; the fifth in Nashville by E. W. Brown on "Resonance in the Solar System"; the sixth in New York City by G. H. Hardy on "An Introduction to the Theory of Numbers"; the seventh in Des Moines by Irving Fisher on "The Application of Mathematics to the Social Sciences"; the eighth, entitled "Reminiscences of Gibbs by a Student and Colleague," by E. B. Wilson in Cleveland; the ninth by P. W. Bridgman in New Orleans on "Statistical Mechanics and the Second Law of Thermodynamics"; the tenth in Atlantic City by R. C. Tolman on "Thermodynamics and Relativity," and the eleventh, entitled "An Elementary Proof of the Theorem Concerning the Equivalence of Mass and Energy," was delivered by Albert Einstein in Pittsburgh. The twelfth lecture was given in St. Louis in December, 1935, by Vannevar Bush on the subject "Mechanical Analysis."

It is the custom of the society to invite the lecturer to print in the *Bulletin* of the American Mathematical Society if he so wishes. Pupin printed elsewhere, a large part of what he had to say appearing in *Scribner's Magazine;* the others have printed in the *Bulletin* and occasionally in addition elsewhere. For example, Professor Tolman's address was printed simultaneously in SCIENCE. The number of people who attend the lectures varies greatly and depends on the nature of the lecture and on the place where it is given. It is not intended that the lectures be popular in the ordinary sense of the term, but that the educated public, including scientists in other fields, should gain from them further insight into the rôle of mathematics.

MEDAL AWARDS OF THE SOCIETY OF CHEMICAL INDUSTRY

THE American section of the Society of Chemical Industry has announced the award of the Chemical Industry Medal for 1936 to Dr. Walter S. Landis, vice-president of the American Cyanamid Company, New York, "for valuable application of research to the chemistry and economics of the fertilizer industries," and of the William H. Perkin Medal for 1937 to Thomas Midgley, Jr., vice-president of the Ethyl Gasoline Corporation, New York, and of Kinetic Chemicals, Inc., Detroit, "for distinguished work in applied chemistry, including the development of anti-knock motor fuels and safe refrigerants."

Dr. Landis was a pioneer in the application of chemistry to the production of concentrated fertilizers, and has played an important rôle in that industry for thirty years. He was probably the first to produce argon in large commercial quantities.

Mr. Midgley's work resulted in the creation of the entire Ethyl gasoline industry with all that this implies—use of higher compression engines, greater flexibility of automobile operation and other advances. Tetraethyl lead in motor fuels adds forty times as much horsepower annually as that which will be supplied by Boulder Dam. Mr. Midgley's more recent discovery of non-toxic refrigerants promises to be equally fundamental in refrigeration and air conditioning.

Dr. Landis will receive the Chemical Industry Medal, founded in 1920 as an "annual tribute to distinction in applied chemistry," formerly called the Grasselli Medal, at a joint meeting of the Society of Chemical Industry and the American Chemical Society on November 6 at the Chemists' Club, New York. He will speak on "Concentrated Fertilizer."

Mr. Midgley will be presented with the Perkin Medal on January 8, 1937. The Perkin Medal was founded in 1906 in commemoration of the fiftieth anniversary of the coal tar color industry, the first medal being awarded to Sir William H. Perkin, discoverer of aniline dyes. The medalist is chosen by a committee representing the American Section of the Society of Chemical Industry, the American Chemical Society, the Electrochemical Society, the American Institute of Chemical Engineers and the Société de Chimie Industrielle.

SCIENTIFIC NOTES AND NEWS

AT a meeting of the General Committee of the British Association on September 11, Sir Edward Poulton, from 1893 to 1933 Hope professor of zoology at the University of Oxford, was elected president for the year 1937. The meeting will be held at Nottingham from September 1 to 8. The present general officers were reappointed and five vacancies on the council were filled by the appointment of Dr. F. W. Aston, Professor Debenham, Professor T. G. Hill, Campbell Smith and J. S. Wilson. The meeting at Cambridge in 1938 will be held from August 17 to 24. The question of a meeting in Australia is under consideration.

DR. CHARLES GORDON HEYD, professor of surgery at Columbia University and consulting surgeon of the Woman's Hospital of New York City, vice-president of the American Medical Association, has been elected president of the association. He succeeds the late Dr.

James Tate Wilson, of Seattle, who died last June soon after taking office.

DR. EDWARD CHACE TOLMAN, professor of psychology at the University of California, was elected president of the American Psychological Association at the recent meeting at Dartmouth College. He succeeds Dr. Clark Hull, of Yale University.

DR. JEAN PERRIN, professor of physical chemistry at the University of Paris, has been appointed French under-secretary of state for scientific research to succeed Mme. Irene Joliot-Curie. It is stated in *The New York Times* that it has been known for some time that Mme. Joliot-Curie desired to drop her connection with the Popular Front Government, but she and M. Perrin have denied that there is any question of conflict of ideas in regard to scientific research.

THE Chemical Society of France has awarded the Lavoisier Medal to Dr. Julius von Broun, professor of chemistry and applied chemistry at the University of Heidelberg.

THE Association of German Chemists has awarded the Justus Liebig Memorial Medal to Dr. Gustav Hüttig, professor of inorganic and analytical chemistry at the University of Prague.

ACCORDING to the *Journal* of the American Medical Association Dr. Fred H. Albee, formerly professor of orthopedic surgery at the New York Post-Graduate Medical School, on a recent trip to South America was made an honorary member of medical organizations in Brazil, Peru, Chile, Argentina and Ecuador; he was elected honorary president of the Brazilian Society of Orthopedic Surgery and Traumatology and appointed a member of the faculty of medicine and surgery of the University of Chile.

MRS. MARGARET M. NICE, review editor of *Bird-Banding,* has been awarded honorary membership in the German Ornithological Society.

AT the Iowa State College John F. Calvert, of the Westinghouse Electric Company, has been appointed associate professor of electrical engineering, and Lewis Miller Headley, of the Johns Hopkins University, associate professor of mechanical engineering. Elizabeth Sutherland has been appointed associate professor of foods and nutrition.

DR. GILBERT LLEWELLYN WOODSIDE has been appointed assistant professor of biology in the department of entomology, zoology and geology at the Massachusetts State College.

DR. CARL HABICH, of Indianapolis, has been appointed chairman of the department of gynecology at the Indiana University School of Medicine. Dr. Jackson T. Witherspoon, of the Tulane University School of Medicine at New Orleans, has been placed in charge of research in the department.

DR. ERNEST C. MCCULLOCH has been appointed associate professor of bacteriology and parasitology in the College of Veterinary Medicine of the State College of Washington and research veterinarian in the experiment station. H. F. Hollands, instructor in agricultural economics in the University of Minnesota, has become assistant agricultural economist.

DR. ELLIS HAWORTH, for the past five years head of the department of science in the junior and senior high schools of Washington, D. C., has been appointed professor of natural sciences and chairman of the division of science and mathematics of the Wilson Teachers College, Washington, D. C.

FRANK C. HOWARD, formerly a member of the department of chemistry at the University of Illinois, has been appointed assistant professor in charge of chemical engineering at the Worcester Polytechnic Institute. Professor Howard succeeds Dr. Daniel F. Calhane, professor of industrial and applied electro-chemistry, who retired this summer.

DR. R. J. GARBER, head of the department of agronomy and genetics of West Virginia University and Experiment Station, has resigned to become director of the Regional Laboratory for Pasture Research of the U. S. Department of Agriculture at the Pennsylvania State College.

DR. CLARENCE H. CLEMINSHAW has been appointed assistant professor of astronomy at the University of Southern California and assistant director of the Griffith Observatory, Department of Parks of the City of Los Angeles, dividing his time between the two institutions. He will not be connected with the University of California, as recently reported in SCIENCE.

WM. E. DICKENSON, for the past thirteen years a member of the staff in zoology of the Milwaukee Museum, has become director of the new Kenosha Municipal Museum.

MAURICE L. HIGGINS has resigned as associate at the Johns Hopkins University to become research chemist with the Eastman Kodak Company, Rochester, N. Y.

Industrial and Engineering Chemistry states that L. C. Flowers, professor of chemistry in the Canal Zone Junior College of the Panama Canal Service, has become associated with the Westinghouse Electric and Manufacturing Company at Springfield, Mass., where he will be engaged as materials and process engineer in the development of processes of refrigerator manufacture.

DR. GEORGE F. FORSTER, professor of biology at Olivet College, Michigan, has been appointed bacteri-

ologist to the Michigan State Department of Health. He will be on leave of absence from the college for a year.

DR. JAMES BRYANT CONANT, president of Harvard University, sailed for England on September 23.

THE first lecture of the 1936–1937 series of the Harvey Society will be given at the New York Academy of Medicine on Thursday evening, October 15, by Dr. Wilder G. Penfield, professor of neurology at McGill University, on "The Relationship of the Cerebral Cortex to Consciousness."

DURING the past academic year the Sigma Xi Club of the University of Florida held public meetings addressed by the following scientific men: Dr. R. A. Emerson, professor of plant breeding, Cornell University, on "The Physical Basis of Heredity"; Dr. E. F. Kohman, research chemist, National Canners Association, on "Chemistry in Relation to Nutrition and Food Preservation"; Dr. J. A. Bargen, surgeon, Mayo Clinic, on "The Repair of Intestinal Tissue after Injury and Inflammation," and Dr. Robert M. Yerkes, director, Yale Laboratories of Primate Biology, on "Anthropoid Apes as the Servants of Man." Officers for the year 1936–37 are as follows: *President,* Dr. W. R. Carroll; *Vice-president,* Dr. P. A. Foote; *Secretary-treasurer,* Dr. P. H. Senn, and *Program Chairman,* Dr. R. B. Becker.

THE Committee on Grants of the American Association for the Advancement of Science desires to call attention to present regulations governing the distribution of funds designated for the support of individual research. Extended notice of the committee and its work was published in SCIENCE for June 12. Blanks for making application for grants may be secured from the Permanent Secretary, Smithsonian Institution Building, Washington, D. C., and when duly filled out should be returned to that officer. All applications for funds to be available in 1937 must reach the Washington office before November 1. The report of the committee will be presented to the council at the Atlantic City meeting and as approved will be published immediately afterwards.

THE educational "Prospectus" of the Brooklyn Botanic Garden for the school year 1936–37, just issued, announces fifty-six courses of instruction—including fifteen for members and the general public, ten primarily for teachers, a course for student nurses and thirty courses for boys and girls of eight to nineteen years of age. The entire nurses training classes of three city hospitals are enrolled for the nurses course. In addition to these courses, the educational program of the garden includes radio talks on plant life, broadcast throughout the year, regular press releases to metropolitan papers, a bureau of free public information on all aspects of horticulture and botany and assistance for those who wish to visit the labeled collections under educational guidance.

Museum News states that an amendment to the state constitution of California giving authority to the state legislature and to local governing bodies to enter into contracts with non-profit corporations, organized under the laws of California, for the management and control of public museums, has been passed by the legislature and will be submitted to a popular vote in the coming election this fall. The amendment was proposed by a legal committee of the Los Angeles Art Association. Its purpose is to make possible permanent, non-political control of public museums, and particularly art museums, in the state.

THE residuary estate of Dr. Horace Phillips will become, after the death of the survivors of four life tenants, the property of the University of Pennsylvania, for the education of young men, "preferably those who take military training in the Officers Reserve Corps of the Army or Navy." It is stipulated that no part of the fund accruing to the university is to be used for the construction of buildings.

ACCORDING to the *Journal* of the American Medical Association, contracts have been awarded for a new clinical building at the School of Medicine of Indiana University, Indianapolis, and construction is expected to begin soon. The total cost of the building will be about $550,000, of which the Federal Government will pay 45 per cent. as a PWA project; the remainder will be paid by the university through a bond issue.

THE College of Medicine of the University of Illinois has received from the Rockefeller Foundation a fund of $15,000 per year for a period of three years to promote undergraduate instruction in psychiatry. This work is under the immediate supervision of Dr. H. Douglas Singer, professor and head of the department of psychiatry. The program in general involves the extension of psychiatric teaching into other departments of medicine, particularly that of internal medicine.

CARL W. BUCHHEISTER, of the Lawrence School at Long Island and director of the new Audubon Nature Camp on Hog Island in Muscongus Bay, Maine, will become secretary of the recently merged Federation of the Bird Clubs of New England and the Massachusetts Audubon Society. He succeeds Winthrop Packard, who has retired after serving as secretary for over twenty-five years. Among the properties turned over to the Audubon Society by the federation are the Isaac Sprague Wild Life Sanctuary on Carr's Island off Newburyport; the Knight Wild Life Reservation on

Milk Island off Rockport; the Boxford Wild Life Reservation at Boxford; the Henry Cabot Lodge Bird Sanctuary at Nahant; the East Sandwich State Game Farm; the Ram Island Sanctuary at Mattapoisett; the Watatic Mountain Wild Life Reservation; the Edward Howe Forbush Wild Life Reservation in Hancock and Billingsgate Island, off North Eastham; the large Annie H. Brown Sanctuary at Plum Island, where the Audubon Society already owns fifty acres adjoining, and Tern Island, off Chatham, where thousands of tern breed. Wild life reservations secured by the federation by gift, purchase or legislation since 1924 amount to approximately 2,000 acres, scattered through the state.

An Associated Press dispatch states that a new law bearing the signature of Premier Mussolini prescribes the oath of loyalty to be taken at once by members of institutes of scientific research in Italy. The oath, which the law says is of "absolute and urgent necessity," reads: "I swear to be faithful to the King, to his royal successors and to the Fascist régime; to observe the Constitution and the other laws of the State and to exercise the office intrusted to me in the spirit of bringing about the greater development of the national culture and science."

Members of the Oxford University Expedition to North East Land, Spitzbergen, arrived in London on September 10. The party, under the leadership of A. R. Glen, has spent fourteen months in the Arctic. It was the first expedition to winter in the interior of North East Land and is reported to have carried out its program with complete success.

A summary of the annual report for 1935 of the Henry Lester Institute of Medical Research, Shanghai, is given in *The British Medical Journal*. In the Clinical Division Dr. Platt has carried out researches on vitamin B_1 with reference to beri-beri. In the Division of Physiological Sciences Chinese factory diets have been investigated as part of a general diet survey with a view to elucidating the nutritional factor in disease. In field medical research special attention has been paid to entomology and parasitology. Mosquito research has been carried out by breeding the insects in special "insectaries" in their natural environment. In the Division of Pathological Sciences advances have been made in the analysis of the antigenic structure of the typhoid bacillus, and in the preparation of a serum, which is already proving of value. Twenty hospitals in other towns, from Tientsin to Amoy, have availed themselves of the Lester Institute for section cutting and histological diagnosis. A bibliography gives a list of seventy-five publications by the staff, the Chinese members being especially prolific in this respect.

DISCUSSION

SUNBURN AND WINDBURN

It is generally believed that exposure of the human skin to ultra-violet light of the sun or to a strong wind may induce therein a red pigmentation, *i.e.*, erythema. As far as we are aware, however, it is not thoroughly understood whether windburn is entirely a direct result of the wind or whether the wind merely makes the skin more susceptible to sunburn. Does a strong wind produce erythema of the skin in the absence of ultra-violet light?

We have made preliminary experiments in pursuit of this question which indicate a negative answer. For example, we have exposed the inner side of the forearm of one of us to the blast of a 40-mile per hour wind in an experimental wind-tunnel. The forearm was covered with a piece of heavy rubber (inner tubing of automobile tire) except for a small area of about one square inch where the rubber was cut away, leaving the bare skin exposed to the blast. There was no ultra-violet light present. The relative humidity of the air was 50 per cent. and the dry bulb temperature was 66° F. During the half hour exposure to the blast the skin exhibited "goose flesh," but at no subsequent time was there the slightest evidence of reddening or chapping of the exposed area of the skin.

Other experiments, to be published shortly in detail, indicate that human sweat partially absorbs ultra-violet light in the spectral region which is effective in producing erythema. A drop of perspiration was placed between two flat plates of crystal quartz separated by a 0.2 mm spacer. This was placed over the inner forearm of one of us and was irradiated with the total radiation of a quartz mercury arc lamp. The skin under the quartz plates developed, in due time, normal erythema, except for the small area of about a square centimeter directly under the 0.2 mm film of sweat, where the reddening of the skin was markedly less than that of the surrounding region.

Spectrophotometric measurements indicate that a 0.5 mm film of human sweat transmits only about 75 per cent. of solar radiation which is effective in producing sunburn. For the total radiation from a quartz mercury arc lamp the transmissivity is somewhat less than this figure.

From the foregoing observations we are led to wonder whether erythema usually attributed to strong winds may not be due, in part at least, to ultra-violet

sunlight, the action of which is intensified by secondary effects of the wind; such as, for example, a variation of the temperature and moistness of the skin[1] and a suppression of perspiration which, were it present, would provide some protection from the actinic rays of sunlight.

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PERIPHERAL DISTRIBUTION OF FORE-LIMB NERVES IN AMBLYSTOMA

THE distribution of plexus nerves to the forelimb in Amblystoma is a controversial matter. The limb is innervated from the third, fourth and fifth segments. Carpenter[1] states that the fifth nerve contributes innervation exclusively to muscles of the wrist. Nicholas and Barron,[2] however, find that electrical stimulation of any one of the three plexus nerves yields contractions in any of the joints of the limb, with possibly a slight prevalence of innervation of distal muscles by the fifth nerve.

In order to decide the question, I have, at the suggestion of Dr. P. Weiss, undertaken degeneration experiments with 6 specimens of Axolotls (*Amblystoma mexicanum*) of approximately 10 centimeters' body length. One of the three plexus nerves was severed and time allowed for degeneration of peripheral fibers.[3] Sections were made and stained by Weigert-Pal myelin method; and counts were made of the normal as well as the degenerated fibers entering the muscles at various levels of the limb.

After the sectioning of any of the three nerves, degenerated fibers were found at all levels of the limb and in all muscles examined. Although a very slight peripheral increase in the ratio of degenerated to normal nerve fibers was indicated after severing the fifth nerve, and possibly a slight peripheral decrease in the innervation ratio of the fourth nerve, the main fact remains that all three plexus nerves contribute fibers to muscles at all levels of the limb, in confirmation of Nicholas and Barron's findings.

J. D. THOMPSON

THE UNIVERSITY OF CHICAGO

[1] See Hill and Eidenow, *Proc. Roy. Soc.*, 95–B, 163, 1923–24; also Coblentz and Stair, *Jour. of Res. of National Bureau of Standards*, 15: 142, 1935.

[1] R. L. Carpenter, *Anat. Rec.*, 58 (suppl.): 7, 1934.

[2] J. S. Nicholas and D. H. Barron, *Jour. Comp. Neur.*, 61: 413, 1935.

[3] As determined by control experiments, it takes about two weeks for the degeneration to become complete in these animals. The tributaries to the limb nerves from the plexuses do not always remain as sharply localized within the peripheral nerve trunks as has been described for the frog by Kurkowsky (*Zeits. f. Anat. u. Entw'ges.*, 104: 389, 1935.)

BITTERLING OVIPOSITOR LENGTHENING PRODUCED BY ADRENAL EXTRACTS[1]

MOST investigators agree that the ovipositor of the bitterling fish can be artificially lengthened by adding certain urine specimens to the water in the aquarium. Adult male urine and urine from pregnant women usually give a positive response, while urine from adult non-pregnant women may or may not cause this reaction. A recent report suggested that the male hormone in urine caused the phenomenon. In a single experiment using two fish we failed to get any response with a large dose of crystalline androsterone, although both fish gave a positive reaction when tested with material known to be potent.

The present experiments were undertaken to see if the source of this material could be located by means of tissue extracts. Due to the availability of material, dog tissues were used in most experiments. The following tissues were extracted with ether and tested on standardized bitterlings as previously described: skeletal muscle, heart, brain, lung, kidney, spleen, liver, pancreas, stomach, thyroid and parathyroids together, testes, pituitary, thymus and adrenal. In most cases 20 grams of raw tissue were employed. The only extracts giving a positive response came from the adrenals. In one case the medulla was trimmed out as well as possible and the remaining cortex gave the same increase in ovipositor as the whole gland. Approximately 0.75 to 1.0 gram of adrenal tissue is necessary for a positive reaction, using the crude method of extraction which we have employed. The adrenals from other species tested have all given positive reactions. These include cat, rat, rabbit, beef, guinea pig and human. Tests with dog urine have been negative in the concentrations used. The work is being continued, and the possible significance of this material in human urine is being investigated.

B. O. BARNES
A. E. KANTER
A. H. KLAWANS

PRINCIPLES OF SCIENTIFIC PUBLICATION

THERE are certain principles which should but usually do not attend the publication of scientific work.

The first is that publication is a part of research.

The second is that the cost of publication should therefore be borne by the institution or individual sponsoring the work.

Regardless of the pain which acknowledgment into practice of these two unassailable principles may cause —they must be put into practice else institutions and workers convict themselves of shirking a just responsibility.

[1] From the Department of Physiology, the University of Chicago, and the Department of Obstetrics and Gynecology, Rush Medical College.

It ought not to be necessary to remind workers and institutions of science that they belong to a highly favored group: they are allowed to work at what pleases them; they are not subject to the time clock; their incomes enable them to live in comfort; and they have no overhead of rent, light, heat, electricity, supplies and clerical or technical assistance to earn before paying salaries. Yet when the suggestion is made that they pay for the means of dissemination of the work done under their auspices the air is rent with cries of anguish.

The benefits might be several if institutions and workers paid for publication of their effusions: subscription costs could be cut and the individual worker could subscribe to more journals and thus increase his usefulness; fewer papers would be written; the papers would be better written and prepared; papers would be shorter when brevity was adequate for exposition and longer when space was needed for clarity; and the literature could carry all necessary tabulations of raw data, while many unnecessary tables, charts and diagrams would be omitted.

To the idea there can be no objection raised which will withstand the cold light of logic—and scientists should be logical.

What more needs be written save that this is no new procedure but one which was generally employed before publication of scientific work became commercialized.

If scientific societies, journal organizations, and the like have the courage to act according to these basic principles, all the difficulties which to-day beset the publication of scientific work and over which there is so much avid discussion will be dissolved, and science will be the better for it.

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FELLOWSHIPS IN HUMAN BIOLOGY

THROUGH the generosity of an anonymous donor there are available a limited number of fellowships for the current academic year in the department of biology of the School of Hygiene and Public Health of The Johns Hopkins University. They are intended for persons interested in problems of human biology. One, carrying a stipend of $1,200, is open only to a worker who has already taken the doctorate. Others with smaller stipends are open to graduate students who have not yet taken the degree.

Applications setting forth the candidate's training, experience and research interests, as well as any letters in support of the application, should be sent promptly to the undersigned at the address above.

RAYMOND PEARL
THE JOHNS HOPKINS UNIVERSITY

SCIENTIFIC BOOKS

CURRENT TRENDS IN GEOGRAPHY

Elements of Geography. By VERNOR C. FINCH and GLENN T. TREWARTHA. McGraw-Hill Book Company, N. Y. 782 pp. 399 illus. 9 plates. 1936. $4.00.

An Outline of Geography. By PRESTON E. JAMES. Ginn and Company, Boston. 475 pp. 182 illus. 24 plates. 1935. $3.00.

Geography, an Introduction to Human Ecology. By C. LANGDON WHITE and GEORGE T. RENNER. D. Appleton-Century Company, N. Y. 790 pp. 333 illus. 1936. $4.00.

Fundamentals of Economic Geography. By NELS A. BENGTSON and WILLEM VAN ROYEN. Prentice Hall, Inc., N. Y. 802 pp. 300 illus. 1935. $4.25.

THE appearance within a year of four excellent college texts in geography, each distinct in treatment and among the best of their type which have yet been written, reflects the vitality of this old and yet very new field. Geography's recognition as an essential college subject has largely developed since the war. To-day almost every prominent central and western university includes a department, although its introduction along the Atlantic seaboard has been less rapid. In European universities it is even more widespread than in this country. The increasingly scholarly character of the subject, as illustrated in these stimulating volumes, should hasten its spread.

In order to appreciate the divergent approach to the first course in college geography, it may be helpful to summarize the historical preface of Finch and Trewartha. In ancient Greece, where geography had its beginnings, it embraced two distinct fields; the description of places and the understanding of a miscellaneous variety of natural phenomena, such as weather, earthquakes, rivers and tides. Until the middle of the nineteenth century this dual interest continued to define the field. Within recent years, four distinct developments have occurred. In the first place, geography has been relieved of the various divisions of natural science which have assumed their independent place as geology, meteorology, etc. With this narrowing of its physical field, the study of land forms received added attention. The four-fold field of physiography, embracing geomorphology or the study of land forms proper, meteorology, oceanogra-

phy and mathematical astronomy, continues to occupy a significant place in geographic interest, but its genetic aspects belong to other sciences.

The third development of recent years is a new emphasis upon the relationships between man and his environment. This field of human geography or ecology has so blossomed in this country that it has often been considered the chief characteristic of American geography. This is a new note in geography, for while students of the earth have always been concerned with interactions there has not until recently been any attempt to proclaim the consideration of man's relations with nature as purely geographic, or to make this the core of the subject. Quite recently, the oldest of all geographic interests, that in areal description, has been vigorously revived by European scholars and a number of younger American geographers. This is regional geography or chorography, the study of places and areas, and is an attempt to define a distinctly geographic field of inquiry. This newest and yet oldest phase of geography stresses the landscape, which embraces not merely what one sees photographically but all those elements, whether natural or man-made, which give character and unity to an area. In terms of a formula, the geographic landscape is composed of the fundament, or the natural environment as it exists apart from modification by man; plus the occupance, or the material impress of man's culture; as modified by succession, or the time factor. In the judgment of the reviewer, this latest development with its emphasis upon field work appears most likely to yield scholarly results and to win the approval of related disciplines.

Three of the books under review consider these different lines of approach. James is a strictly regional treatment of landscape groups, White and Renner is concerned with relationships, while Finch and Trewartha present the component elements, physical and cultural, which make up the areal scene. Bengtson and Van Royen, on the other hand, is a combination of all three which stresses the economic aspects.

"Elements of Geography," by Professors V. C. Finch and Glenn T. Trewartha, of Wisconsin, is essentially a preface to geography proper in that it deals with the various "elements" in the landscape, natural and cultural. A brief closing section is devoted to the five major geographic realms, and other chapters are similarly areal, but the bulk of the volume considers the principles which one must understand before undertaking regional studies. Three quarters of the book deals with the natural elements of the landscape, in which processes are distinguished from the resulting earth features. Climate receives the major emphasis, and is followed by land forms, natural vegetation, soils and mineral resources. One might wish for proportionately fuller consideration of vegetation and soils, but the material is clearly presented and up-to-date. The authors recognize that the second major section of the book is the weakest, that on the cultural elements of the landscape. Geographers are interested in many phases of human activities, but especially as they impress themselves upon the visible earth. Aside from anthropology and agricultural economics, the social studies have generally failed to give the same consideration to the analysis of landscape patterns and their distribution as have the natural sciences. But since the geographic landscape characteristically includes items of settlement, circulation and utilization, it is regrettable that this section of the book is but one tenth as long as the first. As a survey of geographic principles the book is admirable, but in view of the very brief attention given to geographic realms it would appear unfortunate if this should be the student's only contact with geography as a whole.

"An Outline of Geography," by Professor Preston E. James, of the University of Michigan, is based upon the conviction that college geography should aim to clothe the map with meaning; the book therefore plunges directly into the consideration of regional groups without prior attention to principles. This is a new and questionable procedure. The opening chapter considers the dry lands in terms of their natural fundament and human occupance. Scattered through the book are brief sections on climate, soils, topography and settlement, and three lengthy appendices catalogue details of the atmosphere, lithosphere and hydrosphere. Since the book is organized in terms of vegetation units, such as the tropical forest lands, grasslands and boreal forest lands, more consideration should have been given to the principles of plant ecology. Sections on cartography and occupance forms are also needed. The book is overly brief, and the Koeppen symbols are too difficult for underclassmen. Unfortunately, neither this nor the other volumes have any world map of regions on a strictly geographic basis. Despite several details of organization, the geographic philosophy of the book is stimulating and sound. Professor James's volume marks a significant advance in American geography, for the subject here ceases to be merely a collection of interesting data and becomes an organized analysis of landscapes. This emphasis upon *place* is the core of geography.

"Geography, an Introduction to Human Ecology" is by Professor C. Langdon White, of Western Reserve University, and Dr. George T. Renner, of the National Resources Committee. The authors consider that: "wherever mankind has established relationships to the natural environment, those relationships are geography or *human* ecology" . . . "this relationship

concept is the only justification for geography's existence." These adjustments are economic, social and political, and are discussed in connection with the seven "factors" of the natural environment—climatic, biotic, physiographic, edaphic (soils), mineral, hydrographic and spatial. A closing section is devoted to the region as a geographic unit. Throughout the book there is a wealth of data drawn from diverse environments, in all of which man stands out as the central object. White and Renner have written a painstaking and attractive analysis of geographic influences, and their volume is a worthy and temperate successor to Ratzel and Semple. This is the best volume of its type and deserves a wide reading outside of geographic circles. The only question concerns the desirability of the ecological approach, with which some will not agree.

"Fundamentals of Economic Geography," by Professors Nels A. Bengtson and Willem Van Royen, of the University of Nebraska, is designed for students of business, but will undoubtedly find considerable use in liberal arts courses. It follows familiar lines, but with much new material and better balance than other books of its type. It has already been favorably reviewed in SCIENCE.[1]

To compare four different and carefully prepared volumes is difficult. All are well supplied with references and illustrations, and only an author can appreciate the painstaking search which these involve. James is outstanding for the many maps drawn by Raisz and for the colored maps of vegetation, climate and land forms. In quality of illustrations and printing, Finch and Trewartha takes first place, with credit to the McGraw-Hill Book Company. Bengtson and Van Royen is especially comprehensive. White and Renner is perhaps the most interestingly written, but all are well done.

The presentation of geography to general college students in one year presents several practical difficulties. Not the least of these is their almost complete ignorance of simple place information. Only a small fraction of college freshmen can identify three quarters of the states when given an outline map. The geographic void which characteristically follows the seventh grade makes it necessary to introduce material which has little place in a college curriculum. The lack of map knowledge may in part be rectified by a judicious use of Lobeck and Smith's exercises on the "Places of the World." (The Geographical Press, Columbia University).

Where it is desired to have the course stress the adjustments between man and his environment, no better volume has been written than White and Renner. Likewise, where a service course is to be presented to students of business, Bengtson and Van Royen will serve admirably. Both volumes contain enough for a year's course.

On the other hand, if the emphasis is to be on cultural geography with its consideration of the varied landscapes of the earth, the problem of a text is less simple. James is rather short and opens too abruptly. Finch and Trewartha provides the essential elements but is merely a beginning. The best arrangement would appear to be a combination of the two, with Finch and Trewartha used until Christmas or possibly for a semester, followed by James and supplementary case studies. In such a combination all regional portions of Finch and Trewartha might be deferred until later in the year. This twofold division of the year into elements and chorography is somewhat akin to the conventional organization of introductory geology into physical and historical.

In this task of understanding the face of the earth, it is at once apparent that the map is a mosaic of many thousands of communities. Fortunately these may be grouped into regions, and these in turn into realms or landscape groups. Finch and Trewartha defines six realms in terms of climate, while James describes eight groups on a basis of natural vegetation. Neither volume considers individual regions or communities, but if the course is to serve its purpose certain detailed studies would appear desirable. For these, the increasing number of field studies as published in the *Geographical Review* and the *Annals of the Association of American Geographers* provide excellent material. If the class is small, students may be sent directly to the journals, but with larger groups and for institutions with limited libraries there is need for a reference volume of selected type studies. This need is partially met by Glendinning and James's lithoprinted "Representative Regional Studies" (George Wahr, Ann Arbor), but the over-condensation and the absence of illustrations make this brief book of doubtful value. No volume can encompass the earth, but within appropriate limits it should be possible to assemble a selection of detailed studies which would bring the student into intimate contact with reality.

Where shall such a course fit into the crowded liberal arts curriculum? At Wisconsin, the course taught by Finch and Trewartha carries natural science credit; at Michigan James's course rates as a social study; at Chicago the country's oldest department has representation in both divisions. Geography is inevitably at the same time a social and a natural science, as well as an art, and it is unfortunate to insist that it be fitted into an artificial scheme of divisions. One of its values is that of a bridge between the fields which deal with man and with nature; it should not be penalized in the schedule of group requirements because of this duality. Where taught by qualified

[1] SCIENCE, 83: 15–16, January 3, 1936.

geographers, few subjects are so broadening or furnish such a perspective for the world problems of our day. At the same time, the practical applications of geographic techniques are increasingly apparent. To the furtherance of these objectives these volumes make conspicuous contribution.

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SPECIAL ARTICLES

FISH MORTALITY PRODUCED BY OXYGEN DEFICIENCY

THE writers have had various cases of fish mortality brought to their attention during this past winter and have had an opportunity to investigate one rather large and unusual situation located at the ox bow of the Connecticut River about two miles down stream from Northampton, Mass., at the confluence with the Manhan River.

The separation of this ox bow from the main stream resulted from a freshet in 1840 which shortened the channel of the river by about three miles, cutting across the narrow end as illustrated (see cut). The

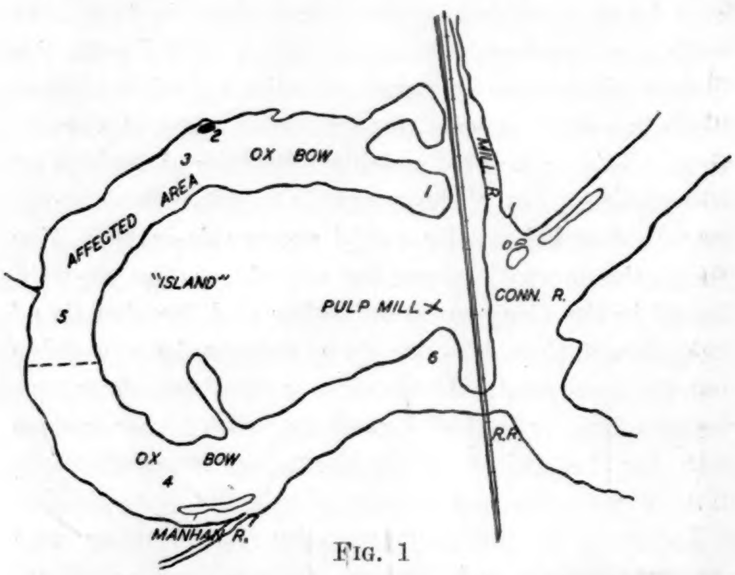

FIG. 1

Manhan joins the ox bow on the outlet side about one mile from the present junction with the Connecticut River. Several miles down stream at Holyoke, Mass., a large power dam exists that has slightly raised and sustained the general level of the river at this place.

During the past winter, the low temperatures in this locality were of quite a long duration. Still water was frozen over from early December to March 10. No thaws of sufficient intensity to break up the ice occurred during this interval.

On February 25 the attention of the writers was called to the large quantities of dead and dying fish at one small opening in the ice of approximately 250 to 300 square feet. This condition was known to have existed on February 23, when a local game warden was notified. At this place several hundred fish of various lengths and of the following species were found.[1]

[1] The writers are indebted to Dr. E. C. Driver, of Smith College, and Dr. R. E. Trippensee for additions to the list of fishes.

Ameiurus nebulosus (LeS.)	*Micropterus salmoides* (Lac.)
Eupomotis gibbosus (L.)	*Esox reticulatus* LeS.
Lepomis pallidus (Mitch.)	*Catostomus commersoni* (Lac.)
Pomoxis sparoides (Lac.)	*Anguilla chrysipa* Raf.
Perca flavescens (Mitch.)	Dace and shiners

Dead fish were observed at air-holes in other parts of the affected area. The large numbers and the wide range of species indicated that death was produced by extraneous causes. Some small fish (probably immature perch) were seen alive at the largest opening and were in no apparent distress.

Station No.	Dissolved O_2
1	0.8
2	0.8
3	0.8–1.6
4	1.6–6.0
5	0.4
6	9.8
7	7.9–8.7

Field determinations of the dissolved O_2 content of the water from February 25 to March 10 in the upper half of the ox bow (the affected area) showed 0.4 to 1.6 parts per million as opposed to 8.0 parts per million in the Manhan River. Near the junction of this river with the ox bow the dissolved O_2 varied from 1.6 to 6.0 parts per million. At the lower end of the ox bow, where the water probably was oxygenated by the Manhan and the operations of a nearby pulp mill, the waters contained 9.8 parts per million of dissolved O_2 on February 25. This last reading may have been affected by the wastes from the mill, but on the date of observation a number of fishermen were catching a few yellow perch at this place, all in apparently good condition. At no time were any dead fish found in this area. The dissolved O_2 showed diminution during the period of observation from February 25 to March 10, from 1.6 parts per million to 0.8 parts per million. The water showed a pH of 5.3 throughout, at all times.

This situation was partially relieved on March 10, because of accumulated rain water which broke through the ice, and completely relieved by the flood of the Manhan River on March 11. On March 10 the small fish formerly observed at the first opening were gone. At the time of the flooding, the extent of the

s of fish became apparent, numbers of dead fish ng observed around the edge of the affected areas.

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PATHOGENICITY AND VIRULENCE OF CERTAIN BACTERIA

INCIDENTAL to studies on the egg-propagation of tain filtrable viruses as previously reported[1, 2] op-rtunity was afforded for observing the effect of troducing several species of bacteria into developing gs of the chicken and other domesticated fowl. At e outset the sensitivity of the embryo and its mem-nes to various filtrable viruses and to numerous ic influences[3, 4, 5, 6] was reflected in the response to e injection of different concentrations of *Salmonella llorum*. With given strains of freshly isolated *S. llorum* the extent and severity of the lesion pro-uced as well as the survival time of the embryo re quite definitely and uniformly correlated with the antity of the inoculum and the virulence of the lture for baby chicks.

These results suggested the possible adaptability of e method of egg inoculation for determining the thogenicity and for ascertaining the virulence of rious strains and species of bacteria. In investigat-g this hypothesis the preliminary observations here corded were confined to inoculations upon the orio-allantoic membrane of eggs incubated 10 to 15 ys prior to treatment. The cultures used repre-nted 4 strains of *Brucella abortus*, var. *bovis* and is, 3 strains of diplococci of equine origin, 3 strains hemophilic bacteria isolated from the upper respira-ry tract of young chickens, 8 species of Salmonella d 3 species of Pasteurella. Eggs employed as con-ols were injected with the sterile suspending medium with suspensions of the various bacteria killed by eat. Proof of infection of the embryo and/or its embranes was established by the production of gross sions and direct pure culture isolation of the organ-m inoculated.

The cultures of diplococci and hemophiles appeared rtually devoid of pathogenicity for the developing g even in the relatively large quantities employed s much as 0.2 cc of the undiluted 15 to 24-hour oth cultures). These 2 groups of organisms in other trials were not proved to possess specific pathogenic properties for the homologous host. Brucella, Pasteurella and Salmonella cultures were lethal to the embryo in very dilute concentrations, while the control suspensions of dead organisms produced no more than slight local injury to the extra-embryonic tissues and were seldom associated with the death of the embryo.

Marked differences in virulence for developing eggs were manifested between smooth stock and freshly isolated cultures of Salmonella and Pasteurella. Simultaneous comparative titrations with Pasteurella cultures on 2 to 10-day old chicks revealed a correlation in results, although much less definite and uniform than in the egg-inoculation method. The *P. avicida* culture, when inoculated subcutaneously, killed chicks in dosages 10^7 times smaller than were required with the *P. equiseptica,* while *P. cuniculicida* required larger doses than *P. equiseptica.* For eggs the *P. equiseptica* and *P. cuniculicida* required dosages approximately 10^4 times greater than did *P. avicida* to kill chicken embryos within 48 hours. Intracranial inoculations of the *P. avicida* and *P. equiseptia* strains into a group of 9 horses gave results which could be interpreted as validating the titrations upon eggs and chicks. However, the more uniform and accurate measurements of virulence obtained by egg inoculation as compared to animal inoculation emphasizes the superiority of the new method.

The delicacy with which differences of pathogenicity and/or of virulence among strains of certain bacteria may be determined by inoculating the developing avian egg suggest that this method may also be utilized to detect alterations in these characters among variants of a certain strain.

The potential value and adaptability of the developing avian egg for other phases of purely bacteriological investigation and experimentation is suggested by the findings here reported and in consequence of the simplicity of application and economy of the method.

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DOWNWARD SHIFT OF pH CAUSED BY ADDITION OF GLUCOSE TO BORIC ACID BUFFER SOLUTIONS

THE accompanying table was prepared for use in a study of O_2 consumption by yeast. It may be useful in other studies. In each test, to 20 ml of boric acid buffer solution (prepared according to Clark: "Determination of H ions," 2d ed., 1928; table 35) was added a known weight of glucose, as shown, and the resultant pH value (at 25°) was measured potentiometrically (quinhydrone electrode).

Table I shows the results obtained with two buffer solutions, having initial pH values of 7.68 and 8.80,

TABLE I

Glucose (g. per 20 ml.)	pH	Glucose (g. per 20 ml.)	pH
No glucose	7.68	No glucose	8.80
0.104	7.21		
0.282	6.78	0.363	7.79
0.733	6.26		
1.159	5.83	1.186	6.95
1.987	5.47	2.353	6.42
3.434	4.96		
4.242	4.79	4.900	5.76
5.553	4.56		
6.412	4.45	7.152	5.47
10.627	4.03	10.868	5.20
13.834	3.82	14.170	4.91
16.613	3.66		
19.101	3.54	19.884	4.60
19.833	3.52		
21.298	3.46	21.127	4.56

respectively. With increasing glucose concentration the glucose effect is seen to have been relatively less pronounced; the effect of adding about 2 g. of glucose produced about half as much depression of pH value as was produced by adding about 21 g., and the difference between the pH depression caused by addition of about 10 g. and that caused by addition of about 21 g. was only about 0.60. The maximal decrease in pH value was the same for both solutions, namely 4.22 and 4.24. The effect was shown to be reversible; after glucose had been added, pH was increased when boric acid or borax was added to the solution. A number of writers have given evidence that glucose may form a union or complex with such substances as boric acid, but the exact nature of the union is still uncertain.

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ISOLATION OF IMMUNOLOGICALLY PURE ANTIBODY

IT is now well known that the polysaccharide prepared from Type I pneumococcus precipitates specifically the antibody from Type I anti-pneumococcus serum. The precipitate so obtained can be washed free from inert proteins. If the washed precipitate is dissolved in dilute alkali, allowed to stand over night and then neutralized, about 50 per cent. of the protein in the precipitate is recovered in a soluble form. This soluble protein can be precipitated from the solution by dialysis (to remove the salts) and adjustment of the pH to 7.6 which may be regarded as its isoelectric point.

The protein so obtained agglutinates, and protects mice from an otherwise fatal dose of, Type I Pneumococci, as does the original serum, but the titer of these reactions is increased 15 to 20 fold. From a 0.2 per cent. solution the protein is 90 per cent. precipitable by the homologous polysaccharide, the remaining per cent. can be accounted for by the solubility of immune precipitate. If the immune precipitate tained with the recovered protein is again dissol in alkali, allowed to stand and neutralized, the prot recovered for the second time has quantitatively same activity as before. The protein may theref be regarded as a pure antibody, at least immunolo cally.

We have made essentially the same observatio with the precipitate obtained from Type I Pneu coccus antisera of horse and rabbit and with Type I Pneumococcus antiserum of rabbit. We have fou it also possible to recover the antibodies from Type I Pneumococcus agglutinate by essentially same method used for the precipitate. The meth described above for the isolation of antibody appears to have a general application.

The isolation of immunologically pure antibody theoretically and practically significant. It has be a debatable question whether antibody is itself a pr tein or something else carried by the protein. O present findings leave little doubt that the antibo itself is a protein. The mechanism of immunologi reactions is not yet clear. Now that pure antibo is available, we can advantageously restudy the mecha nism of immune reactions, especially the precipi reaction. On the practical side, the preparation pure antibody places in the hands of the clinicia therapeutic agents where serum therapy was not pra tical before, *e.g.*, in Type III pneumonia the anti serum for which has a very low antibody content.

The details of our observations will be reported the *Chinese Journal of Physiology.*

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